

Read only

## SCIENTIFIC AND TECHNICAL INFORMATION SYSTEM

1. Acc. Number <b>DS000788</b>	1A. Act. Code <b>AQPO</b>	2. Trans Type <b>M Modify A Record</b>	3. Effort Status <b>C Completed</b>	4. Perf. Meth. <b>C Contract</b>	
Performance Type 5. <b>R RDT&amp;E Work Unit</b>		6. Date of Summary <b>2003/02/24</b>	7. Prec. Sum Date <b>2002/03/18</b>	8. Start Date <b>2000/02/18</b>	9. End Date <b>2001/11/30</b>
10. Sec. Class. <b>U Unclassified</b>	18. Distribution Code <b>A Distribution Unlimited</b>	19. Distribution Reason <b>PB Public Release</b>			

20. Title  
**STP1020, FEASIBILITY OF POLY TRAY LEAK DETECTOR, SINGLE CAVITY**

22. Linking Accession Number (Select Up to Two) <b>2002, STP 1020</b>	23. Local Control Number <b>2002</b>	24. Search Data <b>2002</b>
--	---	--------------------------------

25. Subject Categories	
Code <b>0608</b>	Description <b>Food, Food Service and Nutrition</b>
<b>1308</b>	<b>Manufacturing and Industrial Engineering and Control of Production Systems</b>
26.1 Mission Area	
Code <b>5.1</b>	Description <b>Logistics</b>
26.2 Function Code	
Code <b>7.2</b>	Description <b>Manufacturing Technology</b>
26.3 Technology Code	
Code <b>4.2.2</b>	Description <b>4.2.2 Manufacturing Cell Control Technology</b>
27. Resp. Org. Source <b>432549</b>	27.1 Responsible Organization Name <b>DEFENSE LOGISTICS AGENCY FORT BELVOIR VA</b>
27.2 Responsible Organization Component Name <b>J-339, R</b>	
27.4 Responsible Individual	
Last Name <b>EGGERS</b>	First Name <b>RUSSELL</b>
	MI <b>K</b>

20040521 034

27.5 Resp. Indiv. Off. Sys.  J-339	27.6 Resp. Indiv. Phone  703-767-1417	27.7 Resp. Indiv. DSN No.  427-1417
--	---	---

28. Perf. Org. Source  410970	28.1 Performing Organization Name  RUTGERS - THE STATE UNIV PISCATAWAY NJ
-------------------------------------	---

28.2 Performing Organization Component Name  CENTER FOR ADVANCED FOOD TECHNOLOGY, FMTF
--

28.4 Performing Individual
----------------------------

Last Name  CANAVAN	First Name  JEFFREY	MI  S
--------------------------	---------------------------	-------------

28.5 Perf. Indiv. Off. Sys.  FMTF	28.6 Perf. Indiv. Phone  732-445-6130	28.7 Perf. Indiv. DSN No.
---	---	---------------------------

28.8 Associate Investigator Names (Last, First, MI)
---

**35. Keyword Text**

INTEGRITY

QUALITY

DEFECT(S)

CONTROL

DETECTION

VACUUM

DECAY

CALIBRATE

BENCH TOP

FLEXIBILITY

DUAL USE

SHOP FLOOR

PARTNER

REWORK

IN-PROCESS

OFF LINE

**36.1 Objective**

TO DETERMINE THE FEASIBILITY OF USING A LEAK DETECTOR TO DETECT LEAKS AND WEAK SEALS IN POLYMERIC TRAY PACKS LIKE THE ONE DEVELOPED FOR MRE POUCHES.

**37.1 Approach**

CONTRACTOR TO ACQUIRE A BENCH SCALE UNIT LARGE ENOUGH TO ACCOMODATE A POLYERIC TRY, THEN RUN A VARIETY OF TESTS, AND ULTIMATELY DETERMINING AND REPORTING THE APPLICABILITY AND FEASIBILITY OF THIS TECHNOLOGY FOR PACKAGES LARGER THAN MRE POUCHES, SPECIFICALLY POLYMERIC TRAYS.

**38.1 Progress**

THE PROJECT IS COMPLETED, AND THE FINAL REPORT IS UNDERWAY.

30. Primary PE No.  0708011S	31. 1st Contrib. PE No.	32. 2nd Contrib PE No.
------------------------------------	-------------------------	------------------------

30A. Primary Proj. No.  STP 1020	31A. 1st Contrib. Proj. No.	32A. 2nd Contrib. Proj. No.
--	-----------------------------	-----------------------------

30B. Primary Task No.  2002	31B. 1st Contrib. Task No.	32B. 2nd Contrib. Task No.
-----------------------------------	----------------------------	----------------------------

30. Primary Funding Data			31. 1st Cont. Funding Data			32. 2nd Cont. Funding Data			33. Contract
Fiscal Year	Dollars	Work Year	Fiscal Year	Dollars	Work Year	Fiscal Year	Dollars	Work Year	Rollup Indicator
C1	C2	C3	C1	C2	C3	C1	C2	C3	C
2001	1950	1							
D1	D2	D3	D1	D2	D3	D1	D2	D3	D
2000	8585	1							
E1	E2	E3	E1	E2	E3	E1	E2	E3	E
F1	F2	F3	F1	F2	F3	F1	F2	F3	F
G1	G2	G3	G1	G2	G3	G1	G2	G3	G
39A. Product Set No.			39.1A Prod. Title Class Code		39.2A Product Title				
			Unclassified						
39.3A Product ID/Report No			39.4A Product AD No			39.5A Product Indicator			
39B. Product Set No.			39.1B Prod. Title Class Code		39.2B Product Title				
			Unclassified						
39.3B Product ID/Report No			39.4B Product AD No			39.5B Product Indicator			
39C. Product Set No.			39.1C Prod. Title Class Code		39.2C Product Title				
			Unclassified						
39.3C Product ID/Report No			39.4C Product AD No			39.5C Product Indicator			
39D. Product Set No.			39.1D Prod. Title Class Code		39.2D Product Title				
			Unclassified						
39.3D Product ID/Report No			39.4D Product AD No			39.5D Product Indicator			
39E. Product Set No.			39.1E Prod. Title Class Code		39.2E Product Title				
			Unclassified						
39.3E Product ID/Report No			39.4E Product AD No			39.5E Product Indicator			

34. Contract/Grant/Trans. No. SPO103-96-D-0016	34.1 Contract Effective Date 2000/02/18	34.3 Contract Face Value \$105,350	34.4 Contract Cum. to Date \$105,350
2001/11/30			

40. Dom. Tech Trans.	HI High potential for civilian application
41. Study Category	5 Science, Technology, Systems and Equipment
42. Spec. Study Sub	FE Feasability analysis
44. Prim. Proj. Serial No	
45. Int. Sources Con.	Y
46. Processing Date	2002/03/24
47. Receipt Date	

**49. Thrust Indicator****Technology for Affordability**Focal Point  
**Russell Eggers**Author  
**Russell Eggers**

Status Code

**Submittable to DTIC**

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
<p>The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.</p> <p><b>PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.</b></p>					
1. REPORT DATE (DD-MM-YYYY) 27-03-2002	2. REPORT TYPE FINAL	3. DATES COVERED (From - To) Feb 2000 - Nov 2001			
4. TITLE AND SUBTITLE Polymeric Traypack Integrity: Bench-Scale Unit		5a. CONTRACT NUMBER SP0103-96-D-0016 5b. GRANT NUMBER PR - 88003 5c. PROGRAM ELEMENT NUMBER PE - 7811s 5d. PROJECT NUMBER CORANET STP #1020 5e. TASK NUMBER  5f. WORK UNIT NUMBER			
6. AUTHOR(S) Canavan, Jeffrey S.					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Rutgers, The State University of New Jersey The Center for Advanced Food Technology Cook College, NJ Agriculture Experiment Station New Brunswick, NJ 08903		8. PERFORMING ORGANIZATION REPORT NUMBER FTR-111			
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Defense Logistics Agency 8725 John J. Kingman Rd. Fort Belvoir, VA 22060-6221		10. SPONSOR/MONITOR'S ACRONYM(S) DLA 11. SPONSOR/MONITOR'S REPORT NUMBER(S)			
12. DISTRIBUTION/AVAILABILITY STATEMENT					
<b>DISTRIBUTION STATEMENT A</b> Approved for Public Release Distribution Unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT This report documents the evaluation of a prototype bench-scale leak tester for the polymeric traypack. The traypack is a replacement for the group feeding metal traycan. Lids of polymeric traypacks are foil laminate film like the material used in MRE pouches and seals are thermal welds. Holes and seal defects found in MRE production can be expected in polymeric traypacks. At leak detection the unit was 100% effective at non-destructively detecting holes and leaks 200 microns or greater. Additional experimentation was conducted to determine the applicability of the unit for non-destructive residual gas testing since current destructive tests represent a substantial continuing expense. Analysis of experimental data indicates that the linear relationship between force and residual gas can be modeled with reliable results for 2 of 3 products tested with the prototype unit.					
15. SUBJECT TERMS field rations, polymeric traypack, leak detector, production unit, advanced technology, defects, holes, residual gas, open seal, foil laminate, rigid tray, packaging, integrity					
16. SECURITY CLASSIFICATION OF: a. REPORT U		17. LIMITATION OF ABSTRACT b. ABSTRACT U	18. NUMBER OF PAGES c. THIS PAGE U	19a. NAME OF RESPONSIBLE PERSON 19b. TELEPHONE NUMBER (Include area code)	
28					

**COMBAT RATION NETWORK  
FOR  
TECHNOLOGY IMPLEMENTATION**

**Polymeric Traypack Integrity: Bench-Scale Unit**

**Final Technical Report STP 1020**

**Results and Accomplishments (February 2000 - November 2001)**

**Report No: FTR 111**

**CDRL Sequence: A004**

**March 2002**

**CORANET CONTRACT NO. SPO103-96-D-0016**

Sponsored by:  
**DEFENSE LOGISTICS AGENCY**  
8725 John J. Kingman Rd.  
Fort Belvoir, VA 22060-6221

Contractor:  
Rutgers, The State University of New Jersey  
**THE CENTER FOR ADVANCED FOOD TECHNOLOGY**  
Cook College  
N.J. Agricultural Experiment Station  
New Brunswick, New Jersey 08903

Principal Investigators:  
**Jeffrey S. Canavan**

**Neal Litman**

**Dr. John F. Coburn**  
Program Director

**DISTRIBUTION STATEMENT A**  
Approved for Public Release  
Distribution Unlimited

**TEL: 732-445-6130 FAX: 732-445-6145**

## TABLE OF CONTENTS

<b>1.0</b>	<b>Introduction.....</b>	<b>3</b>
<b>2.0</b>	<b>Background .....</b>	<b>3</b>
<b>3.0</b>	<b>Results and Recommendations .....</b>	<b>4</b>
3.1	Economic Estimates.....	5
<b>4.0</b>	<b>Short Term Project Activities, Phase I .....</b>	<b>6</b>
4.1	Acquire Bench-Scale Unit .....	6
4.2	Develop Operating Parameters .....	6
4.3	Determine Performance .....	6
4.3.1	<i>Leak Detection</i> .....	6
4.3.2	<i>Residual Gas</i> .....	6
4.3.3	<i>Weak Seals</i> .....	8
4.4	Finalize Design and Software .....	8
<b>5.0</b>	<b>Appendix.....</b>	<b>9</b>
5.1	Experiment Data and Analysis.....	10
5.1.1	<i>Creamed Ground Beef</i> .....	10
5.1.2	<i>Pork Sausage in Brine</i> .....	12
5.1.3	<i>Turkey Slices in Gravy</i> .....	14
5.2	Leak Tester Prototype Unit.....	16
5.2.1	<i>Design Specifications</i> .....	16
5.2.2	<i>Interface Screen Image with Suggested Alterations</i> .....	23
5.3	Vendor Proposal.....	24

## **1.0 Introduction**

STP #1020 began on February 18, 2000 based on a Technical Proposal dated September 2, 1999. The overall objective was to investigate an automated inspection system for polymeric Traypack products. During this STP, a Bench-scale, single station unit was acquired and evaluated. The Bench-scale unit was based on the MRE pouch Multiple Unit Leak Detection system, MULD, along with the iTi-Qualitek bench unit currently in use for MRE pouches. This work forms the basis for assisting the DOD/Traypack producers in selecting systems for in-line plant use and startup of that equipment.

## **2.0 Background**

The polymeric tray replacement for the metal tray-can is an urgent program of great importance to the Military Services, especially since past metal cans have shown evidence of premature deterioration. Since the lid of a polymeric traypack is the same material as presently used in MRE pouches and its seal is a thermal weld (as contrasted to metal can seams), the hole and seal defects which occur in MRE production can be expected in the new Polymeric Traypack. Puncture of the polymeric tray bottom, although physically possible, is expected to be of low incidence. CAFT-Rutgers has completed commercialization of an on-line, automated leak detector (MULD) which has been implemented with MRE pouches.

In spite of significant investment in manpower for the inspection tasks, the final rate of rejection of MRE lots for pouch abrasions, open seals, and holes is 3%. Evidently the human inspection system is not as effective as it needs to be. The results of STP #75, "Leak Detector Implementation", indicated that human inspection accuracy is approximately 50% and that the bench-scale leak detector is capable of attaining 80-100% accuracy. Tests with the Plant-scale, Multiple Unit Leak Detector (MULD) have given results in the 90-100% range. Experience with Polymeric traypack products during the Traypack Manufacturability studies, STP#1002, indicated that holes and cuts in the lid were rare. The principal defects observed were in the seal area due either to lid stock performance or variation in traypack lip thickness. USDA inspection data for 2001 for polytrays shows lot rejection rates for open seals and leakers to be 0.9% and 2.6% respectively.

The MULD unit can also estimate headspace (residual air) non-destructively. Current acceptance and QA procedures require destructive headspace testing. Manual testing for headspace with the traypack leads to significant product loss. The current method is also time consuming and messy. The application of the benchtop unit for measurement of residual gas in traypacks was investigated.

### **3.0 Results and Recommendations**

The prototype Bench-scale unit was installed, tested, and accepted from the subcontractor. As a leak tester, the unit has been 100% effective at detecting leaks 200 microns or larger. The technology and mechanics of leak testing carry over faultlessly from the MRE bench-scale and MULD units. An MULD for the polymeric traypack would be as or more effective as the MRE MULD units. The most likely location for a hole is in the lid stock of the tray and the tray contains more residual gas than the MRE pouch. Therefore it is less likely that the hole would get "plugged" by the product and not detected.

However, as a residual gas tester, it is recommended that more research be conducted with a unit that incorporates a more advanced testing software and mechanics if consistent non-destructive residual gas testing is desired. Although iTi-Qualitek's unit proved useful to demonstrate the applicability of residual gas prediction based on force measurement, to be useful in a plant environment significant changes to the base design are recommended. The force sensor plate height should be self-adjusting to compensate for varying fill weights and product heights. The accuracy of a standard set of formulas would be greatly increased if the variations caused by fill weights and product heights are eliminated by design.

The analysis software for a residual gas tester should include a more function-specific interface to provide easy to understand screen and on-line help. Different product correlation formulas should be easy to add and data should be seamlessly recorded without user intervention. An integrated and dedicated vacuum system should be included with the unit to reduce the possibility of problems during test cycles from other equipment.

#### **Next Steps**

While the primary objective of this STP was to develop and validate a leak tester, significant interest has been expressed in a non-destructive residual gas tester. While the above unit has demonstrated feasibility, modifications were identified which would make the system more accurate. It is recommended that a follow on project be issued that would take the learnings from this project, survey the market for alternate systems, evaluate these alternate systems and recommend the best possible non-destructive residual gas system to the industry. Besides iTi-Qualitek, two additional companies have been identified that claim capability in this area: Intertech, Inc IL and PTI, Tacaho NY, so far for this evaluation.

Intertech, Inc. of Illinois has been working on altering one of their commercially produced benchtop testers to measure residual gas in polytrays. Lead-times for delivery of Intertech's more advanced systems that are already programmed for gas testing are currently 8-12 weeks. After a system is fabricated to better suit the needs of residual gas testing, a study could be funded to partner with a producer to test the unit during regular production. Production data can be collected and correlated to post retort gas measurements. Once a producer is confident with the accuracy of the system, it would be possible to reduce in process and post process destructive tests for residual gas. A transition period during which both methods are employed would be required for operators to gain familiarity with the machine and the algorithms. Once a statistically significant data array is collected, destructive tests could be phased out completely.

### **3.1 Economic Estimates**

Significant cost savings could be realized if non-destructive residual gas tests are substituted for destructive methods. Depending on annual production rates, savings could range from \$57,120 to \$856,800 per year based on the following assumptions;

300,000 trays/year production (peace time requirements), 2,200 trays produced per 8-hour shift

$300,000/2,200 = \sim 136$  shifts, 1 shift = 1 lot

Each lot requires (based on C inspection level)

5 End item residual gas tests by the producer

5 End item residual gas tests by USDA

32 trays/shift residual gas 'In Process', (4 per hour, 8 hour shift)

Total 42 trays per shift       $136 \times 42 = 5712$  trays/year

For annual rates of 300,000 units/year

\$10/tray \$57,120	\$12/tray \$68,544	\$15/tray \$85,680	Potential savings
--------------------	--------------------	--------------------	-------------------

For annual rates of 3,000,000 units/year (war time requirements),

\$10/tray \$571,200	\$12/tray \$685,440	\$15/tray \$856,800	Potential savings
---------------------	---------------------	---------------------	-------------------

iTi-Qualitek has estimated price for the fabrication of additional fixed height sensor units to be \$35,000-\$40,000 each, plus a software change cost of \$5,000. The previous mentioned Intertech, Inc. currently produces commercial leak test units that incorporate automatically adjusting sensors, non-proprietary, open software, and integral vacuum and compressed air systems. Intertech has indicated that benchtop test units based on the specifications required for the polytray would be about \$50,000-\$60,000 each. Since at least one other company produces commercially available units based on advanced design elements with short lead times, it is recommended that other manufacturer's products be reviewed.

## **4.0 Short Term Project Activities, Phase I**

### **4.1 Acquire Bench-Scale Unit**

The test methodology used was that of the MRE Pouch Multi-Unit Leak Detector (MULD) and MRE Pouch, Bench-scale unit. From the units proposed by iTi-Qualitek for the polymeric traypack, detailed requirements were defined for the system selected. Subcontracting the unit ended up taking significantly longer than originally anticipated. Once subcontracting was completed, machining issues and chamber leaks slowed fabrication of the unit. Over-scheduling and lack of resources at iTi-Qualitek led to additional slippage. The first portable PC received from a third party vendor was defective and required replacement. The prototype Bench-scale unit was installed, tested, and accepted from iTi-Qualitek.

### **4.2 Develop Operating Parameters**

Out of the box performance of the test program yielded satisfactory results with some minor fine-tuning of the vacuum set point. Reducing the test delay time and test time parameters did not appreciably change experimental results. Total cycle time was reduced from about 1 minute to 30 seconds. There was an increased accuracy for formulas calculated from force measurements between 20,000 and 40,000 grams as compared to lower forces. Depending on the product and the target headspace, the vacuum set point needed to be set to between 750mbar and 875mbar to achieve 20,000 to 40,000 grams of force. The initial pressure plate was solid aluminum. An air stone material was added to the plate. The material allowed airflow through the plate and provided better detection of holes within the plate contact area. Plate height was kept constant throughout the experiments. Optimally, the plate should be adjusted for each tray to rest on the surface of the top. However in practice, the unit was effective at leak detection with a slight bit of space to compensate for variability in tray volumes with pumpable products.

### **4.3 Determine Performance**

#### **4.3.1 Leak Detection**

Leak detection performance was 100% effective after the installation of the air stone pressure plate. Testing of 20 trays under varying conditions and hole locations was absolutely conclusive for holes 200 microns or larger. Leaks were found in every instance and no false positive trays were identified.

#### **4.3.2 Residual Gas**

The current iTi-Qualitek software interface and analysis algorithm installed on the prototype unit was not designed for residual gas testing. Its primary function is leak detection. The default screen displays the test results at the end of each cycle. A graph of the force during the entire test cycle can be accessed on a separate screen, but cannot be saved. Force information that can be used to estimate residual gas is logged to a data file.

Unfortunately, the default test screen does not include the force measurement or graph. Suggested software improvements include an operator interface for entering correlation data as well as a residual gas calculation. iTi-Qualitek estimates that screen and program changes would incur a one-time charge of about \$5,000. See Appendix 5.2.2 for suggested screen and program alterations.

Even if screen and program changes were incorporated into the existing design, the fixed sensor height will cause significant operational problems in practice. Each product will require analysis to calculate a formula to correlate headspace to force since product height and fill weight significantly affect the force measurement with a fixed plate height. After a formula for each product is estimated, the test procedure would require weighing each tray and entering the value into the test screen before each test. However, even with tray weight taken into account, tray lid height variation for turkey slices trays has been shown to cause significant inaccuracy in residual gas estimation. Experiments with turkey slices in gravy prior to retorting showed very low correlation between force and residual gas. The reason for the poor correlation can probably be attributed to the fact that the turkey were not fully submerged in the gravy and therefore the sensor could not detect gas expansion in between the slices.

As a process control tool to predict residual gas, the unit can be used to provide feedback of headspace trends during production runs without destroying trays. Samples could be taken more frequently at less cost. Significant software changes could be incorporated into the current iTi-Qualitek program to estimate headspace based on pre-determined formulas. However, problems may develop in use if trays vary significantly in temperature and/or fill weights. As trays cool, water vapor condenses and causes a reduction in headspace. Trays measured at higher temperatures will appear to have much more residual gas than will be present at cooler temperatures or if measured by traditional methods. The iTi-Qualitek system relies on a force sensor at a fixed height above the tray lid. The height can be changed by the fabrication of different sensor plate thicknesses, however the procedure for changing plates would be cumbersome. Variation between different products and production fill weights leads to variation in force measurement and estimated gas measurement. Since a major benefit this unit can provide is in process monitoring of residual gas levels, most sampling will likely occur within the plant before retorting. If hot fill products are tested just after sealing, water vapor will be present in the headspace. Traditional destructive tests cause the water vapor to condense. However, water vapor in a sealed tray will expand under vacuum and lead to a higher force measurement than would occur after the tray has cooled. In order to overcome these errors, since temperature effects residual gas estimation, the unit should automatically measure the tray temperature and make appropriate compensation. Alternatively, the test procedure could include a step to cool trays in a water bath prior to testing to condense the water vapor in the headspace, but this would be time consuming and not very practical.

The current procedure for determining headspace is to puncture a tray under water and measure the gas with an inverted graduated cylinder. The tray's contents cannot be reused and the test is quite messy. Headspace can be estimated by inserting the tray's net weight and the force measured during the test cycle into a formula derived from previous

measurements and manual results. Derivation of a force correlation formula would be required for every product. There is no generic formula that can accurately predict headspace from force across different products with a fixed sensor plate height. Each formula would be product specific. Significant variation in tray temperature, product characteristics, and filling will affect the accuracy of the estimation and therefore need to be accommodated by the software.

The force - net weight to headspace correlation formula can be calculated by applying regression analysis tools to a spreadsheet of experimental data. Microsoft Excel has regression analysis functionality. Data collected on retorted trays with pumpable products indicates a linear relationship between force and headspace. Formulas have been able to predict residual gas within  $\pm 2\%$  at 100-120 cc and  $\pm 8\%$  above 240cc. See Appendix 5.1 for additional experimental data and analysis.

#### **4.3.3 Weak Seals**

A non-destructive method cannot be used to create vacuum force equal to typical burst pressures of 20psig. The highest pressure differential for a package sealed with no vacuum under a near perfect vacuum would be equivalent to an internal pressure of 14.7psi. Unless procedure specifications are amended, vacuum testers cannot be used to replace destructive burst testing as is currently defined. Weak seals may be tested with a vacuum tester, but the forces during a test cycle would be lower than currently specified.

#### **4.4 Finalize Design and Software**

See Appendix 5.1.1 Design Specifications, Diagrams and Images, and 5.1.2 Interface Screen Images and Suggested Alterations.

## **5.0 Appendix**

### **5.1 Experiment Data and Analysis**

#### **5.1.1 Creamed Ground Beef**

#### **5.1.2 Pork Sausages in Brine**

#### **5.1.3 Turkey Slices in Gravy**

### **5.2 Leak Tester Prototype System**

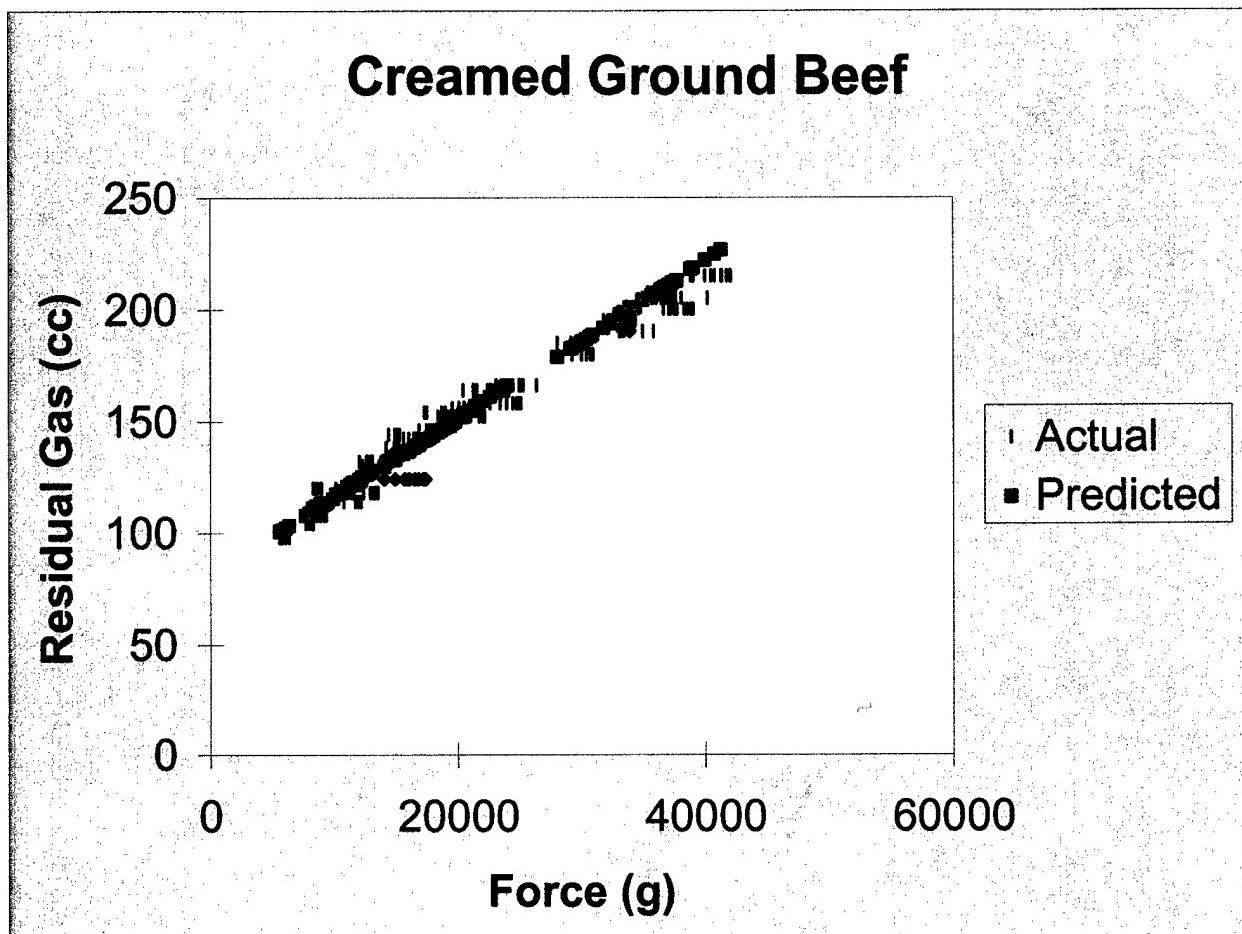
#### **5.2.1 Design Specifications**

#### **5.2.2 Interface Screen Images and Suggested Alterations**

### **5.3 Vendor Proposal**

## 5.1 Experiment Data and Analysis

### 5.1.1 Creamed Ground Beef in Polymeric Traypack



Residual gas estimation plot vs. traditionally measured gas volumes. Based on constants calculated from the following regression analysis.

Simple Regression - RG vs. Force Regression Analysis - Linear model:  $Y = a + b \cdot X$

#### SUMMARY OUTPUT

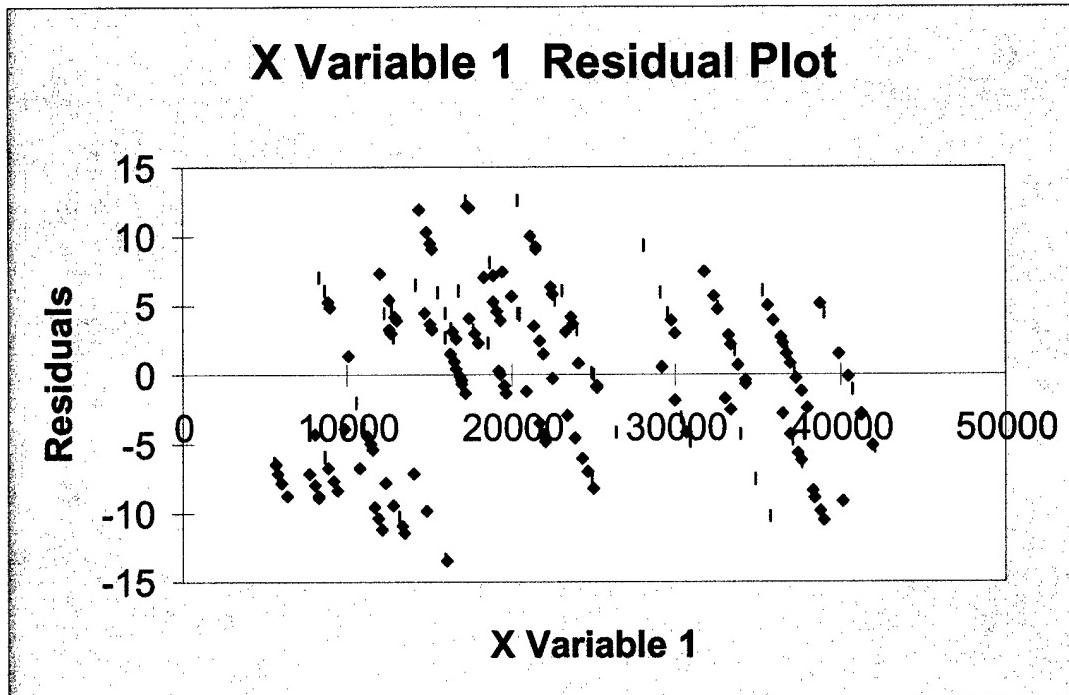
Regression Statistics	
Multiple R	0.978649541
R Square	0.957754925
Adjusted R Square	0.957494153
Standard Error	7.217448721
Observations	164

ns

ANOVA

	df	SS	MS	F	Significance F
Regression	1	191320.2	191320.2	3672.767	3.1E-113
Residual	162	8438.834	52.09157		
Total	163	199759			

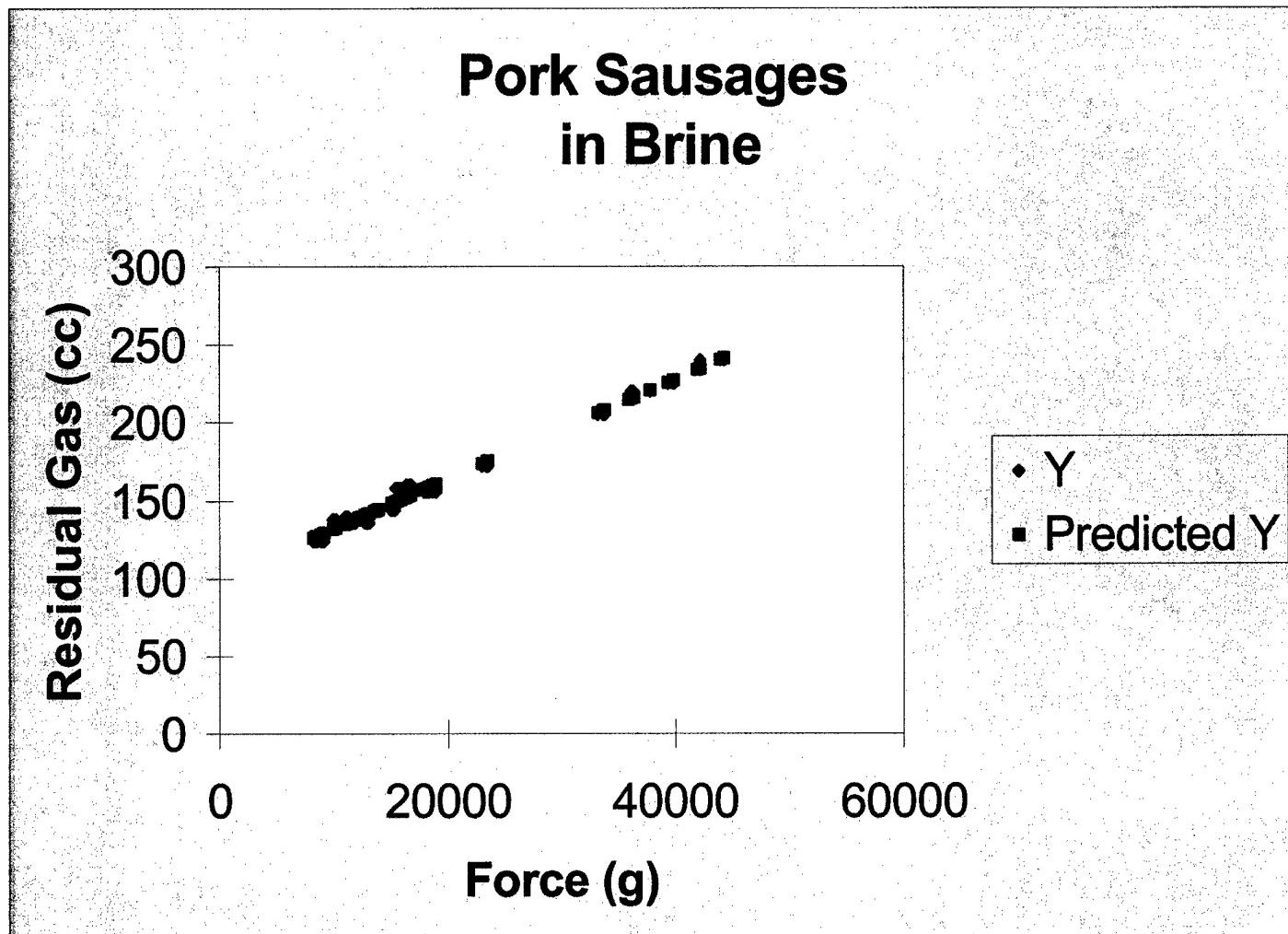
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	81.64855801	1.245995	65.52881	1.6E-118	79.18807	84.10905	79.18807	84.10905
31749	0.003401852	5.61E-05	60.60335	3.1E-113	0.003291	0.003513	0.003291	0.003513



Average Absolute Deviation for 163 samples; 1.4%  
Median Absolute Deviation for 163 samples; 1.6%  
Max Absolute % Deviation for 163 samples; 10.9%

Based on an R square of .9577, the measured force model explains 95.8% of the observed residual gas (y variation). The sample model would be a great tool to estimate gas volume from force.

### 5.1.2 Pork Sausages in Brine



Residual gas estimation plot vs. traditionally measured gas volumes. Based on constants calculated from the following regression analysis.

Simple Regression - RG vs. Force Regression Analysis - Linear model:  $Y = a + b \cdot X$

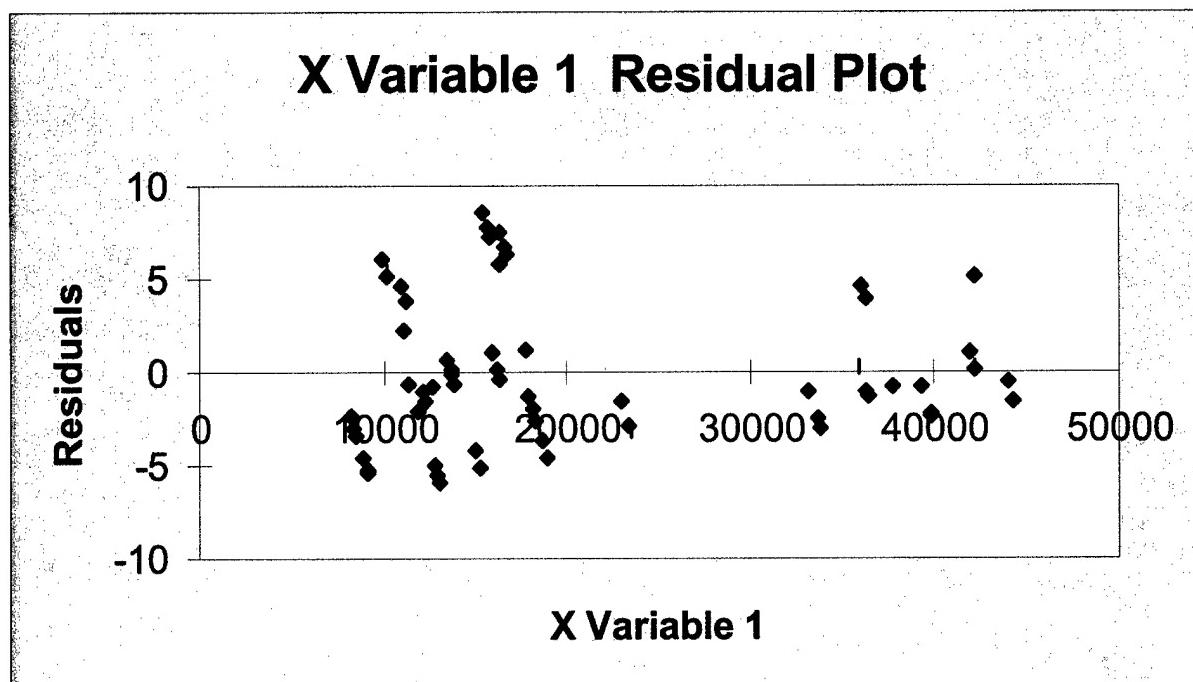
#### SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.99459
R Square	0.98921
Adjusted R Square	0.989041
Standard Error	3.873627
Observations	66

### ANOVA

	<i>df</i>	SS	MS	F	Significance F
Regression	1	88037.14	88037.14	5867.192	1.14E-64
Residual	64	960.3191	15.00499		
Total	65	88997.45			

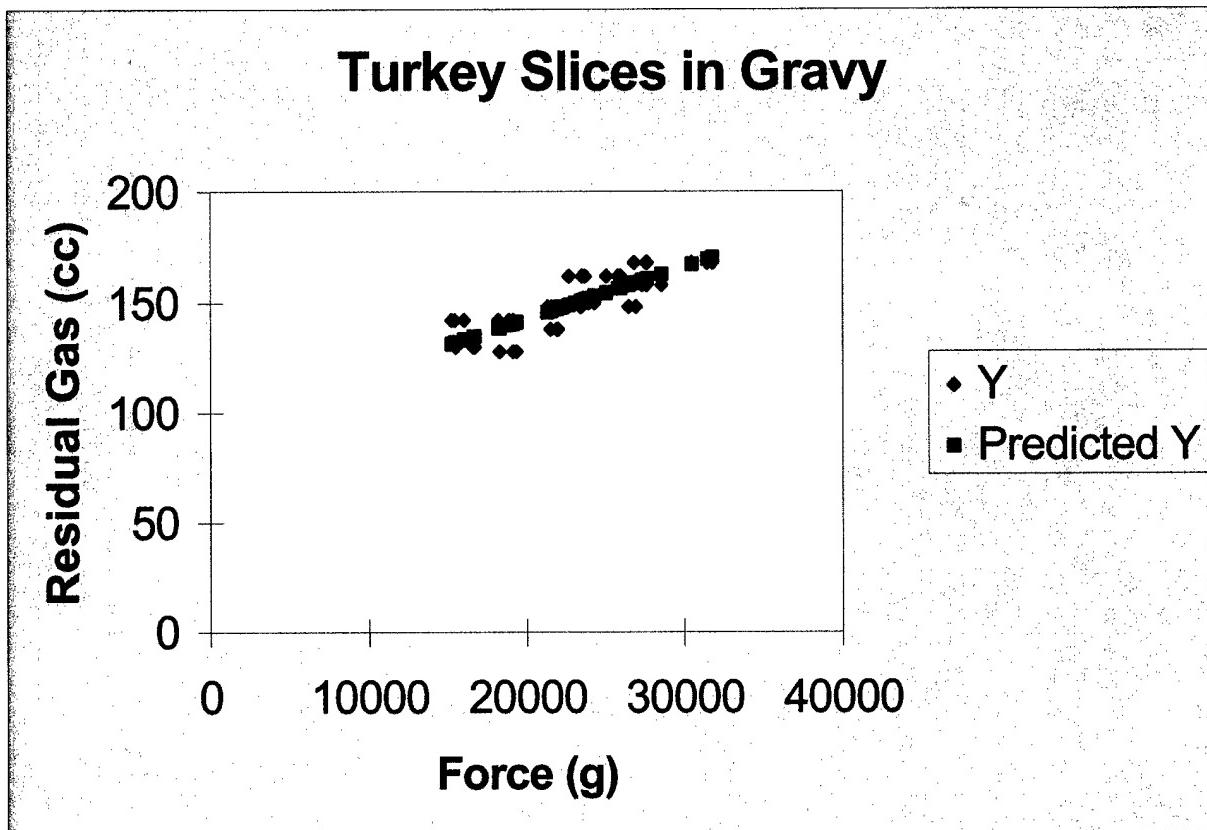
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	100.3323	0.993452	100.9936	2.72E-72	98.34764	102.3169	98.34764	102.3169
X Variable 1	0.003189	4.16E-05	76.5976	1.14E-64	0.003106	0.003272	0.003106	0.003272



Average Absolute Deviation for 66 samples; 2.0%  
 Median Absolute Deviation for 66 samples; 1.7%  
 Max absolute % Deviation for 66 samples; 5.4%

Based on an R square of .9892, the measured force model explains 98.9% of the observed residual gas (y variation). The sample model would be a great tool to estimate gas volume from force.

### 5.1.3 Turkey Slices in Gravy



Residual gas estimation plot vs. traditionally measured gas volumes. Based on constants calculated from the following regression analysis.

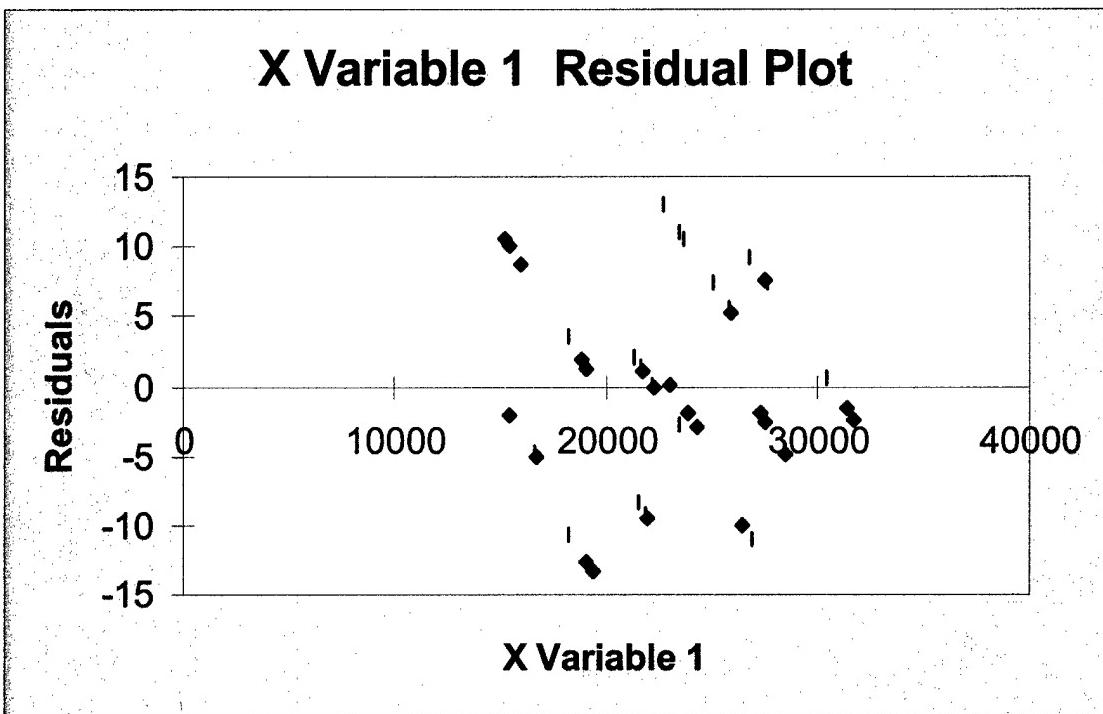
Simple Regression - RG vs. Force Regression Analysis - Linear model:  $Y = a + b \cdot X$   
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.826947
R Square	0.683841
Adjusted R Square	0.675734
Standard Error	7.252412
Observations	41
ns	

**ANOVA**

	df	SS	MS	F	Significance F
Regression	1	4436.893	4436.893	84.35563	2.69E-11
Residual	39	2051.302	52.59748		
Total	40	6488.195			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	95.7821	5.953486	16.08841	8.24E-19	83.74005	107.8241	83.74005	107.8241
X Variable 1	0.002348	0.000256	9.184532	2.69E-11	0.001831	0.002865	0.001831	0.002865



Average Absolute Deviation for 41 samples; 3.9%  
Median Absolute Deviation for 41 samples; 3.5%  
Max absolute % Deviation for 41 samples; 10.4%

Based on an R square of .6838, the measured force model explains only 68.4% of the observed residual gas (y variation). The sample model should be improved to incorporate additional variables to better predict y variation (residual gas). Force can only explain 68.4% of the measured variance.

## **5.2 Leak Tester Prototype Unit**

### **5.2.1 Design Specifications**

---

RFP#

The State University of New Jersey

RUTGERS

Cook College - Center for Advanced Food Technology

CORANET Program

#### Specifications

for

#### **Polymeric Traypack Integrity: Bench-Scale Tester**

This specification covers the requirements for a machine that tests military polymeric traypacks for leaks and residual gas under the CORANET Program under STP #1020 - "Polymeric Traypack Integrity: Bench-scale Unit." The CORANET program demonstration site uses equipment for research and development of new packaging methods and materials.

Rutgers has developed a non-destructive vacuum leak test method for MRE pouches, significantly improving the defect detection capability in production (Multi-Unit Leak Detection system). The objective of this project is to build a bench-scale unit suitable for developing operating parameters for the polymeric traypack by applying the same technology.

This specification consists of the following sections:

1. Functional Description
2. Performance Requirements
3. Package Information
4. Design Requirements

5. General
6. Acceptance
7. Shipping and Installation

## **1.0 Functional Description**

A single station traypack test unit. The tray will be hand loaded into a cavity which forms a sealed vacuum chamber. Pressure within the chamber is then quickly reduced by a self contained vacuum system. Response of the tray is detected by a load cell sensor and evaluated by the control system. The control system and operator display will employ features of MULD system to the extent practical.

## **2.0 Performance Requirements**

2.1 Leak Detection Accuracy. The system will detect defects with equivalent accuracy as the MULD. Minimum hole size 300 micron.

2.2 Operation. The system will run a test cycle equivalent to the method used on the MULD.

## **3.0 Package Information**

3.1 Military Polymeric Traypack. Traypack conforms to MIL-PRF-32004. Lidstock will be either three or four layer laminate construction. Trays are filled with retorted food products such as; beef stew, chicken and rice, ham slice. Trays contain 0-600cc residual air and inspected at 85°F ±15.

3.2 Commercial Institutional Tray. CPET Tray MX-104128-25 produced by Mullinix Packages or equivalent. Lidstock will be a laminate structure whose primary component is nylon, with peelable seals that yield at 2-3psi internal pressure. Trays are filled with macaroni and cheese or similar product. Trays contain up to 1000cc residual gas and are inspected from 32-150°F.

## **4.0 Design Requirements**

4.1 Material Handling.

Trays will loaded/unloaded manually with minimal effort and without the use of tools. Customized infills or carriers for each tray style is permitted.

#### 4.2 Controls.

4.2.1 Control System. The leak tester will be supplied with all necessary controls, including data acquisition boards and PC as needed.

4.2.2 Control Panel. The leak tester will retain the look and feel of the MULD to the extent possible.

4.2.3 Information Display. The leak tester will retain the look and feel of the MULD to the extent possible.

4.2.4 Data Collection. Test results will be stored in files using the same format as the MULD to the extent possible.

4.3 Test Method. The leak tester will subject each tray to preset vacuum (Pressure mode) or to a preset force (Force mode), making a determination of leaks using a force sensor. The sensor should be designed for the forces generated during tests without damage.

#### 4.4 Vacuum System

4.4.1 The leak tester will be supplied with a vacuum pump including piping, valves, accumulator and manifolds as needed.

4.4.2 The final vacuum pressure within the test chamber(s) must be uniform and remain constant during the test.

4.4.3 The final vacuum pressure must be reproducible within 5mBar at 1 sigma and adjustable to 28 inches Hg.

4.4.4 The final vacuum pressure must be reached within 2.0 second.

4.5 Construction. The equipment shall be constructed of stainless steel or anodized aluminum. The chamber should be designed for the forces generated during tests without distortion or damage. Chamber seals should be maintenance-free with a reasonably long life. The sensor position relative to the tray must be adjustable. The design must accommodate tray lids that are concave or convex, up to .5 inch below/above tray flange. An observation window with internal chamber illumination is requested.

4.6 Electrical. The machine shall be wired for 120.

4.2 Pneumatic service up to 100 PSI.

4.7 Physical dimensions of the proposed equipment are to be provided.

4.8 Cleanability. The equipment shall be designed for easy cleaning.

4.9 Safety. The vendor will provide equipment that is safe to operate. Safety guards, safety interlocks and emergency stop buttons are to be provided where required to prevent injury to operators.

## 5.0 General

5.1 Cost. The proposal is to include the total cost F.O.B. Rutgers University, Food Manufacturing Technology Facility, Piscataway, NJ. Cost of optional equipment, recommended spare parts, accessories, installation and freight should be individually quoted.

5.2 Delivery Schedule. The vendor will specify the delivery schedule.

5.3 Service. The vendor will provide service as needed to fulfill requirements of the warranty and these specifications.

5.4 Documentation. A set of manuals that document equipment operational procedure, calibration, maintenance and cleaning procedure will be supplied with the equipment. Drawings supplied as needed.

5.6 Award. Selection will be based on technical evaluation of proposals by the CORANET staff on the following criteria:

- Delivery
- Performance
- Engineering Features
- Cost
- Service
- Training

5.7 Exceptions. The vendor may take exception to a part of this specification without being disqualified from consideration but is to clearly identify any exceptions taken.

5.8 Warranty. The vendor warrants the equipment performance specified herein for one year from the date of acceptance. The warranty includes all equipment and software supplied to be free from defects in materials and workmanship.

## **6.0      Acceptance**

An acceptance test will be run at Rutgers U. FMTF. The test will verify these specifications have been met.

## **7.0      Shipping and Installation**

7.1 The equipment will be shipped F.O.B., Rutgers University, Food Manufacturing Technology Facility, 120 New England Ave, Piscataway, NJ 08854.

7.2 The vendor will assemble and install equipment in full working order and provide training to Rutgers and plant personnel in the operation and maintenance of the equipment.

**Memorandum**

Date: June 14, 2000

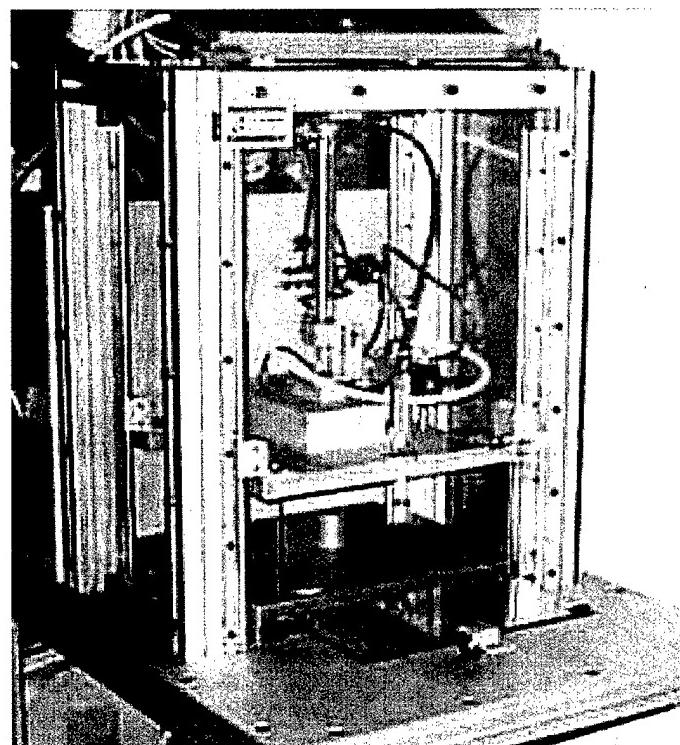
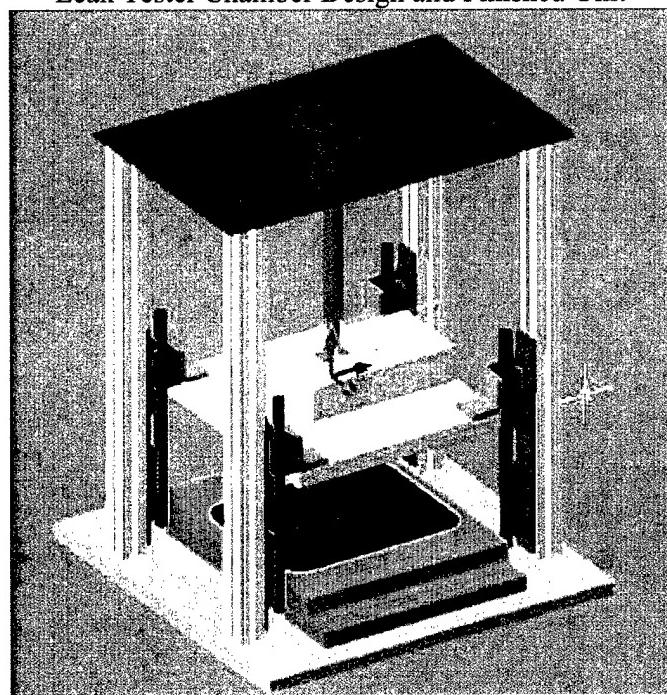
To: Files

From: Neal Litman  
Principal Investigator

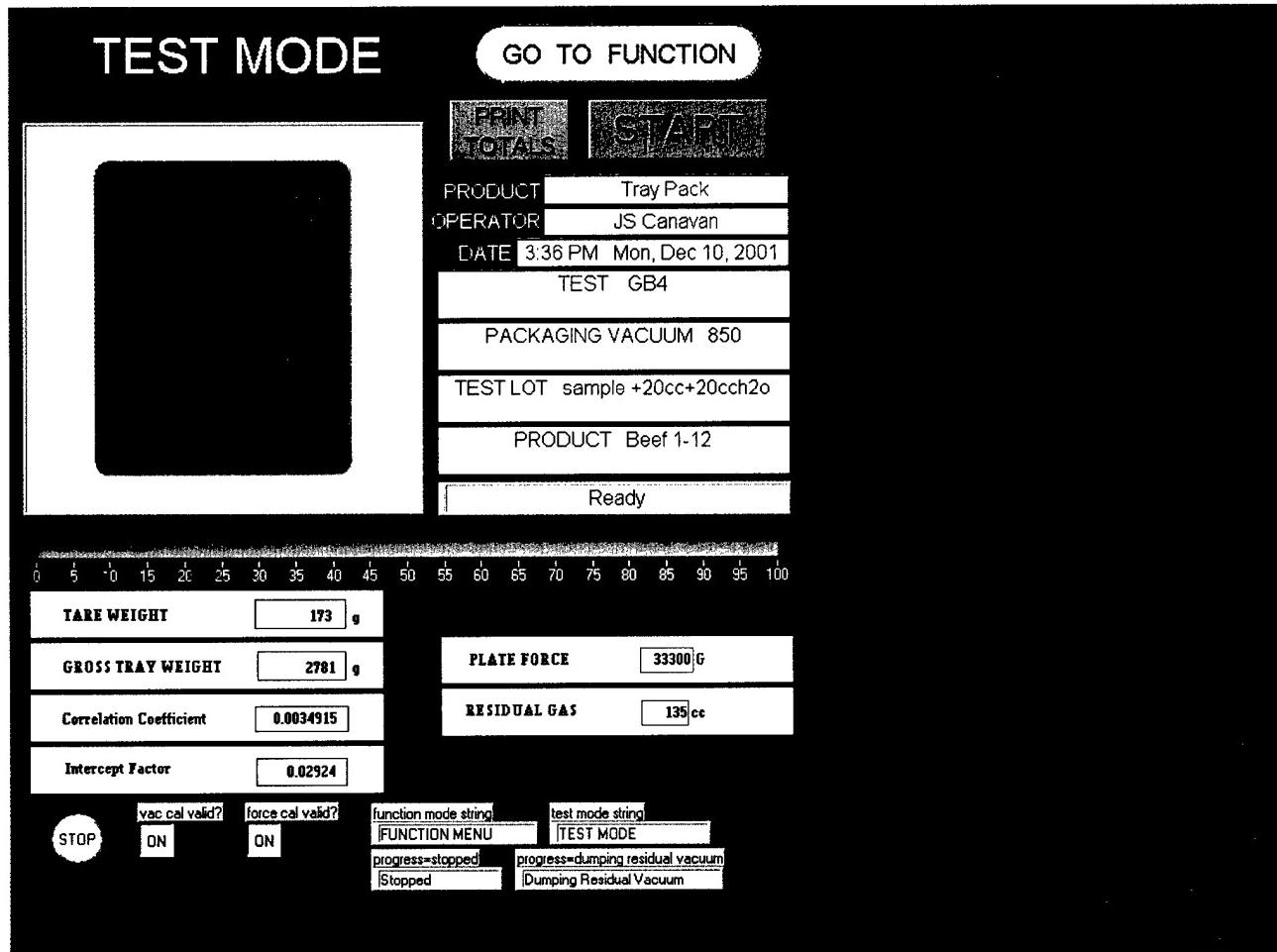
Re: Memorandum of Negotiation for Bench Scale Tester for Polymeric Traypack Integrity

ITI-Qualitek Proposal No. 7216 represents the final fixed cost quotation for Polymeric Traypack Integrity: Bench Scale Tester for which Rutgers University Food Manufacturing Technology Facility is required to build and demonstrate under the CORANET Program Contract. The Proposal was developed from extensive discussions, specification review, site visits and preliminary engineering as defined by the Specifications. As a result of these discussions, the cost was reduced by \$6,240 from the original quotation. This unit will be based on unique technology developed under a previous equipment development project for which ITI-Qualitek provided the sensors and software. I am confident ITI-Qualitek will complete this system to our satisfaction under the terms and conditions proposed.

Leak Tester Chamber Design and Finished Unit



### 5.2.2 Interface Screen Image with Suggested Alterations



Recommended changes to the interface screen are the bottom six, white windows. The four white blocks on the left represent user-input blocks for entering Tare Weight, Gross Tray Weight, Correlation Coefficient, and Intercept Factor. The windows on the left are fields calculated after the test procedure. The measured plate force would be used to estimate the residual gas by the following example calculation;

$$(\text{Correlation Coeff.} \times \text{PLATE FORCE}) + ((\text{Net Weight} \times \text{Intercept Factor}) + \text{constant}) = \text{RESIDUAL GAS}$$

Programming changes should include a user interface screen to enter values, variables, and formulas for the residual gas calculation. The values shown on the proposed default display should be directly accessible for alteration. Entered values should remain between tests, to reduce user input.

### **5.3 Vendor Proposal**



## **PROPOSAL**

**Quote #** 7216

**Response to:** The State University of New Jersey  
RUTGERS, Cook College  
Center for Advanced Food Technology  
CORONET Program  
RFP # \_\_\_\_\_

**Issued By:** Neal Litman  
CAFT/Food Manufacturing Facility  
Rutgers, The State University of New Jersey  
120 New England Ave  
Piscataway, NJ 08854

**System:** Polymeric Traypack Integrity: Bench Scale Tester

Proposal Issued: March 21, 2000

Quote Valid through: April 30, 2000

## Polymeric Traypack Integrity: Bench Scale Tester

### 1.0 Functional Description

A single station traypack test unit. The tray will be hand loaded into a cavity via a drawer mechanism. The drawer when closed will form a sealed vacuum chamber. Pressure in the chamber will be quickly reduced via an external vacuum system, which is not included. Response of the tray is detected by a load cell sensor located above the tray. Response is fed to a PC based control system. The control system and operator display will be substantially similar to the MULD system. Unlike the MULD, the single station traypack test unit will not have a touch screen and there will be no PLC interface.

### 2.0 Performance

2.1 Leak Detection Accuracy. The tester will be capable of detecting defects with the equivalent accuracy of the MULD. Similar to the MULD, minimum detectable hole size may vary based on the product inside the tray and whether or not that product has moved into the leak path.

2.2 Operation. The unit will run a test cycle equivalent in sequence to the method used on the MULD. The single station traypack test unit will evacuate faster than the Q171 bench top tester due to the reduced amount of free volume inside the test chamber and enlarged vacuum port.

### 3.0 Package Information

3.1 Military Polymeric Traypack. Traypack dimensions \_\_\_\_" W x \_\_\_\_" L x 2" D. Lidstock will be either three or four layer laminate construction. Trays will contain 100cc - 175cc of residual air. Trays will be tested at 85°F, ± 15.

3.2 Commercial Institutional Tray. dimensions \_\_\_\_" W x \_\_\_\_" L x 2.5" D. Lidstock will be a laminate structure, the primary component being nylon with peelable seals that yield at 2 to 3 psi internal pressure. Trays will contain 400cc - 600cc of residual air. Trays will be tested at 32°F to 150°F.

- 4.0 Design Requirements

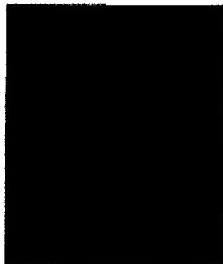
4.1 Material Handling Material handling will be manual. Trays will be hand loaded into the chamber drawer. Chamber infill will support the tray along the bottom and sides to limit tray deflection. Chamber may incorporate aluminum carrier used on packaging line.

4.2 Controls

4.2.1 Control system will include all controls necessary including PCB and Daq cards. Customer will supply the PC which will be a PC based machine with a minimum processor speed of 266Mhz, 2.0gb hard disk memory, 64mb RAM, Windows NT 4.0 operating system, color SVGA monitor.

4.2.2 Control Panel will retain look similar to the MULD. Unit will not have a touch screen.

4.2.3 Information Display will retain look similar to the MULD. Test screen requires modification to mimic test screen on MULD which shows 5 data fields including Test Vacuum(mb), Evac Force(grams), Stab Force(grams), Decay(grams) and Vacuum Decay(mb). Example:



4.3 Test Method. The leak tester will subject each tray to a preset vacuum. (Vacuum Mode). Force mode on a Q730 based unit would be a major modification Evacuation of the chamber will cause the lidstock to expand as the pressure in the tray exceeds the pressure in the chamber. This expansion will generate a force on the load cell sensor. Upon achieving vacuum, the evacuation valve will close and vacuum in the chamber will be held constant. The tray and the chamber will be given time to stabilize. After stabilization, the control software will monitor the force being exerted on the load cell to determine if the tray is leaking. Excess residual gas will be detected by the tray exerting excess force on the load cell at standard test vacuum. The sensor will have a dynamic range of 0g - 48,000g. This is the same sensor used in the MULD.

**4.4 Vacuum System.** The vacuum system will be supplied by the user and should be capable of evacuating the test chamber to a maximum of 28 inches Hg within 2 seconds. Final vacuum pressure should be repeatable to within 5mbar at 1 sigma.

**4.5 Construction.** In an effort to keep the overall weight down, the chamber will be constructed primarily of aluminum. The chamber will be designed to accept forces with a minimum of deflection and no damage. Chamber seals will be of a type that will require minimal service and long life under normal use. The sensor will be above the tray similar to the MULD. The sensors position relative to the lid will be accommodated via different infills when changing from the military tray to the commercial institutional tray. The sensor height will be adjustable manually to accommodate different tray thicknesses among similar products. Sensor adjustment stroke will be a minimum of  $\frac{1}{2}$ ".

**4.6 Electrical.** The tester will be wired for 120v 60Hz with necessary fuses to prevent damage from power surges.

**4.7 Pneumatic Service.** The unit will require air pressure of not less than 75psi to drive the sensor stroke device. Air supply must be clean & dry. Unit will have an onboard filter/regulator.

**4.8 Physical dimensions.** The dimensions of the test unit will be approximately 54" high which includes the height of the cart table, 36" deep and 24" wide. Final design dimensions and weight will be determined upon completion of engineering phase.

**4.9 Cleanability.** The equipment (test chamber) shall be designed to support easy cleaning.

**4.10 Safety.** The equipment will be designed and constructed for safe operation.

## **5.0 General**

**5.1 Cost.** As outlined in Appendix A

**5.2 Delivery Schedule.**

Proposal to Rutgers	March 21, 2000
Contract Awarded (start date)	April 30, 2000
Acceptance Test	Award date + 20 weeks.
Delivery, Training, Installation	Acceptance test + 3 weeks.

**5.3 Service** Service including software and hardware as needed to fulfill of warranty

**5.4 Documentation.** A set of documents will be provided with the system.

Documentation will include:

5.4.1 Users Manual for system operation, calibration and maintenance.

5.4.2 Technical Manual for software operation beyond scope of user functions

5.4.3 Drawings of test chamber, system interface to services

**5.5 Training.** Delivery will include training for administrator level user, operator level user, as well as maintenance and calibration training.

**5.6 Warranty** The warranty shall include all equipment and proprietary software to be free of significant defects in materials and workmanship for one year from date of delivery. This warranty does not apply to customer supplied components including computer, PC operating system.

**5.7 Terms.**

**5.7.1 Payments Milestones**

Customer acceptance of chamber design, (pre-manufacture). 30%

Completion of Acceptance Test at ITI Qualitek. 50%

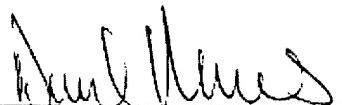
Delivery / Installation / Training 20%

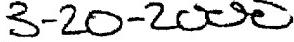
**5.7.2 Payments**

All payments are net 30 days

**6.0 Acceptance Test**

Acceptance test will be performed at the ITI Qualitek facility in N. Billerica, MA. The tests will verify specifications have been met.

  
\_\_\_\_\_  
Dave Morris, President  
ITI Qualitek

  
\_\_\_\_\_  
Date